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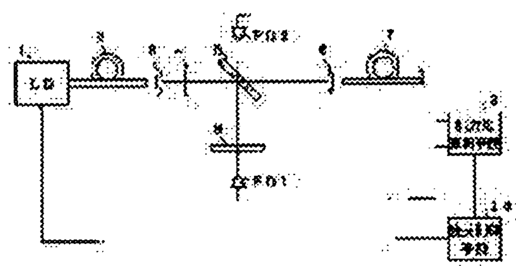
(54) LASER BEAM SOURCE DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide with a very simple constitution a laser beam source device wherein emission wavelength is accurately controlled.

SOLUTION: The beam emitted from a laser diode 1 is made incident on a beam splitter 5, and its reflected beam is supplied to an optical bandpass filter 8. The beam which transmits the optical bandpass filter 8 is photodetected with a photodiode PD1. The beam reflected on the optical bandpass filter 8 and transmitting the beam splitter 5 is photodetected with a photodiode PD2. The emission wavelength of a laser beam source is controlled so that the photodetection ratio between the photodiodes PD1 and PD2 is constant, so that a laser beam of accurate wavelength is emitted.



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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The laser light source to which the wavelength of light can be changed continuously, and the beam splitter to which incidence of the laser beam of said laser light source is carried out, and it branches the laser beam by which incidence was carried out in the transmitted light and branching light, The optical filter which incidence is carried out, and the branching light of said beam splitter makes penetrate the light of predetermined wavelength, makes reflect others, and carries out incidence to said beam splitter again, The 1st photo detector which receives the transmitted light of said optical filter, and the 2nd photo detector which receives the light which penetrates said beam splitter among the branching light reflected by said optical filter, Laser light equipment characterized by providing a power ratio calculation means to compute the power ratio of said 1st and 2nd photo detector, and the wavelength control means which controls the luminescence wavelength of said light source so that the power ratio by said power ratio calculation means serves as a predetermined value.
[Claim 2] Said beam splitter is laser light equipment according to claim 1 which sticks some two optical fibers and is characterized by carrying out welding and constituting.
[Claim 3] Said optical filter is laser light equipment according to claim 1 characterized by being the interference light filter constituted by carrying out the laminating of the low refractive-index film and high refractive-index film which have lambda/4 of optical thickness to the transmitted wave length lambda to multiplex by turns.
[Claim 4] It is laser light equipment according to claim 3 which said interference light filter changes the optical thickness continuously so that the transmitted wave length lambda may change continuously to the predetermined direction of a substrate, and is characterized by said laser light equipment being what has further the slide adjustment device in which the incidence location to said interference light filter of the branching light which branched by said beam splitter is continuously changed to said predetermined direction.
[Claim 5] An error detection means to detect a difference with a predetermined reference value for the power ratio by which said wavelength control means was computed with said power ratio calculation means, A reference-value setting means to set a reference value as said error detection means, and the light source driving means which controls the luminescence wavelength of said laser light source so that the error value detected by said error detection means is set to 0, Laser light equipment of claim 1-5 characterized by being characterized by providing given in any 1 term.
[Claim 6] Laser light equipment of claim 1-5 characterized by preparing further the cut-off filter which makes the transmitted wave length of said optical filter cut-off wavelength between said laser light sources and said beam splitters given in any 1 term.
[Claim 7] Laser light equipment of claim 1-6 given in any 1 term by which it is characterized [which is what has further the temperature-compensation means which carries out temperature compensation of the power ratio computed by the account power ratio calculation means including a temperature detection means to measure the temperature around said optical filter].

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the laser light equipment for stabilizing the wavelength of laser light sources, such as semiconductor laser used for optical communication etc., and oscillating.
[0002]
[Description of the Prior Art] In current optical communication, the wavelength multiplex communication system to which the amount of transmissions is made to increase sharply compared with the case where the light of single wavelength is used is examined by multiplexing the light of much wavelength to an optical fiber, and communicating to it. In order to transmit the laser beam of much wavelength at intervals of 1nm or less in the band of the comparatively narrow wavelength which can amplify a lightwave signal as it is in order to realize wave-length multiple telecommunication, it is necessary to stabilize the wavelength of a laser light source enough. Moreover, in optical information processing and optical measurement, wavelength stabilization of a laser light source is an important technical problem because of informational densification or highly-precise-izing of measurement.
[0003] In order to stabilize the luminescence wavelength of a laser light source, using the component which has a wavelength property used as criteria, an error with luminescence wavelength is detected by a certain approach, and it returns to a laser light source. Therefore, ~~the wavelength of the light or the light source which serves as criteria conventionally using equipment, the holography, the grating or the Mach-Zehnder interferometer, and Fabry-Perot interferometer which stabilize wavelength on the basis of it using absorption of an atom or a molecule is modulated by the dither, and the approach which adjusted wavelength is learned.~~ A dither is vibrating the wavelength of light slightly by a certain approach, and luminescence wavelength is stabilized by distinguishing a difference and a direction with the wavelength which serves as criteria by this, and returning to a laser light source. Moreover, it considers as the criteria of wavelength using a multilayer interference light filter, an etalon, etc., and the approach which stabilized the luminescence wavelength of a laser light source is also used.
[0004] Moreover, in JP,60-74687,A, a dither is not applied, but the light from semiconductor laser is separated, an optoelectric transducer detects the level of the light which passes each filter using two filters with which the wavelength penetrated slightly differs, and the method of returning to semiconductor laser so that the optical intensity ratio may become fixed is proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, since such a conventional approach gave a delicate change to the light source by the dither, changed luminescence wavelength, distinguished the direction electrically, detected a changed part to criteria and has fed it back to the semiconductor laser which is the light source, the light of the light source will be modulated. Therefore, it might lap with the modulating signal as information, and in order to lose the effect of a dither, there was a fault that electrical filters, such as a low pass filter, etc. were needed. Moreover, in order to use a dither, when a control system became complicated and a dither was accompanied by moving part, there was a fault that it was unreliable and a life became short. moreover -- although a beam splitter etc. is needed in the approach of JP,60-74687,A in order to branch light -- a beam splitter -- the effect of polarization of light -- winning popularity -- moreover, temperature -- a spectrum -- the ratio was changeable and there was a fault that it was difficult to make the component which branches light to stability by the predetermined ratio ideally. Moreover, there was a fault that it was difficult to manufacture two optical filters with which transmitted wave length differs slightly also about a filter.

[0006] Furthermore, in order to use a stable light, the part is added to a wavelength stabilizer using the beam splitter which branches a laser beam, and it considers as the laser beam which had others stabilized. For this reason, there was a fault that a beam splitter was needed apart from wavelength stabilization equipment.
[0007] This invention is made paying attention to such a conventional trouble, and it aims at offering the laser light equipment which can emit light in the laser beam of the wavelength which was made to unify a beam splitter and a wavelength stabilizer and was stabilized with high degree of accuracy by the very easy configuration.
[0008]
[Means for Solving the Problem] The laser light source to which invention of claim 1 of this application can change the wavelength of light continuously, The beam splitter to which incidence of the laser beam of said laser light source is carried out, and it branches the laser beam by which incidence was carried out in the transmitted light and branching light, The optical filter which incidence is carried out, and the branching light of said beam splitter makes penetrate the light of predetermined wavelength, makes reflect others, and carries out incidence to said beam splitter again, The 1st photo detector which receives the transmitted light of said optical filter, and the 2nd photo detector which receives the light which penetrates said beam splitter among the branching light reflected by said optical filter, It is characterized by providing a power ratio calculation means to compute the power ratio of said 1st and 2nd photo detector, and the wavelength control means which controls the luminescence wavelength of said light source so that the power ratio by said power ratio calculation means serves as a predetermined value.
[0009] Invention of claim 2 of this application is characterized by for said beam splitter sticking some two optical fibers, having carried out welding, and constituting in laser light equipment according to claim 1.
[0010] Invention of claim 3 of this application is characterized by said optical filter being an interference light filter constituted by carrying out the laminating of the low refractive-index film and high refractive-index film which have lambda/4 of optical thickness to the transmitted wave length lambda to multiplex by turns in laser light equipment according to claim 1.
[0011] Invention of claim 4 of this application is set to laser light equipment according to claim 3. Said interference light filter The optical thickness is continuously changed so that the transmitted wave length lambda may change continuously to the predetermined direction of a substrate. Said laser light equipment It is characterized by having further the slide adjustment device in which the incidence location to said interference light filter of the branching light which branched by said beam splitter is continuously changed to said predetermined direction.
[0012] Invention of claim 5 of this application is set to the laser light equipment of claim 1-5 given in any 1 term. Said wavelength control means An error detection means to detect a difference with a predetermined reference value for the power ratio computed by said power ratio calculation means, It is characterized by being characterized by providing a reference-value setting means to set a reference value as said error detection means, and the light source driving means which controls the luminescence wavelength of said laser light source so that the error value detected by said error detection means is set to 0.
[0013] Invention of claim 6 of this application is characterized by preparing further the cut-off filter which makes the transmitted wave length of said optical filter cut-off wavelength between said laser light sources and said beam splitters in the laser light equipment of claim 1-5 given in any 1 term.
[0014] Invention of claim 7 of this application is taken as the description which has further the temperature-compensation means which carries out temperature compensation of the power ratio computed by the account power ratio calculation means including a temperature detection means to measure the temperature around said optical filter, in the laser light equipment of claim 1-6 given in any 1 term.
[0015] According to this invention which has such a description, a laser light source is made to emit light and incidence of the laser beam is carried out to a beam splitter. A beam splitter carries out incidence of the laser beam which penetrated a part of light, branches others, and branched to an optical filter. An optical filter penetrates the light of predetermined wavelength and reflects others. The light which reflected with the light which penetrated the optical filter and penetrated the beam splitter again is received by the 1st and 2nd photo detector, respectively, and the power ratio is computed with a power ratio calculation means. And the laser beam of predetermined wavelength can be made to emit light by controlling the luminescence wavelength of a laser light source so that a power ratio serves as a predetermined value. Invention of claim 3 realizes such an optical filter with the interference light filter by multilayers. Moreover, if the light-receiving location is changed using the interference light filter of wavelength good transformation which constituted the multilayers interference light filter so that transmitted wave length might change

continuously to a predetermined direction as shown in claim 4, the luminescence wavelength of a laser light source can be changed. Moreover, in invention of claim 5, the reference value is set up with the reference-value setting means, and the difference of the power ratio and reference value which were computed by the error detection means with the power ratio calculation means is detected as an error. And by controlling a laser light source so that an error is set to 0 by the light source driving means, the luminescence wavelength of a laser light source can be tuned finely. Furthermore, by invention of claim 6, by preparing a cut-off filter between the light source and an optical filter prescribes only one slope part as a locking point among the properties of an optical filter.

[0016]

[Embodiment of the Invention] Drawing 1 is the block diagram showing the whole laser light equipment configuration by the gestalt of operation of the 1st of this invention. In this Fig., a laser light source emits light in the laser beam of one line spectrum using the laser diode (LD) 1 of a distribution feedback mold with the gestalt of this operation. The luminescence wavelength of this laser light source is controllable by the current or temperature control from the exterior in less than 2-3nm. This laser beam is led to an optical fiber 2.

[0017] The lens 3 which makes parallel light the laser beam by which incidence is carried out to the other end of an optical fiber 2 from an optical fiber 2, and the cut-off filter 4 which shades a part of light of incident light are formed, and the light which passed the cut-off filter 4 is given to a beam splitter 5. By vapor-depositing a metal membrane and the dielectric a large number film to a glass substrate, a beam splitter 5 is an optical branching means to branch light, penetrates a part of incident light, and reflects others. Incidence of the transmitted light is carried out to an optical fiber 7 through a lens 6. A measuring device, an optical-communication device, etc. which make the stable laser beam the light source are connected to the other end of an optical fiber 7. Now, the light which branched by the beam splitter 5 is given to the optical band pass filter 8. This optical band pass filter 8 is arranged at right angles to the branched laser beam, and it is constituted so that it may have fixed transmitted wave length. And the photodiode PD 1 which is the 1st photo detector is arranged in the location which penetrates the optical band pass filter 8, and the photodiode PD 2 which is the 2nd photo detector is arranged to this and a symmetric position, i.e., the location which receives the reflected light of the optical band pass filter 8 exceeding a beam splitter 5. The output of photodiodes PD1 and PD2 is given to the power ratio calculation means 9. The power ratio calculation means 9 computes the power ratio of two input signals, and outputs a monitor signal, and the output is given to the wavelength control means 10. The wavelength control means 10 controls the luminescence wavelength of a laser light source so that the power ratio by the power ratio calculation means 9 serves as a predetermined value. The luminescence wavelength of a laser light source shall be adjusted by changing the drive current of a laser diode 1, or changing ambient temperature.

[0018] Next, the power ratio calculation means 9 and the wavelength control means 10 are explained using drawing 2. The output from the 1st and 2nd photodiode PD1 and PD2 is given to the I/V converters 11a and 11b within the power ratio calculation means 9, and is changed into a voltage signal. The output of I/V transducer 11b is given to the amplifier 12 which has the gain corresponding to the branching ratio of a beam splitter 5 later mentioned in order to compensate the output level of a photodiode PD 2. The output of I/V converter 11a and amplifier 12 is given to an adder 13 and a subtractor 14, and each output is added and subtracted and is given to a divider 15. A divider 15 normalizes the light received by photodiodes PD1 and PD2, and detects the wavelength of input light based on these power ratios. The I/V converters 11a and 1b, amplifier 12, the adder 13, the subtractor 14, and the divider 15 constitute a power ratio calculation means 9 by which the power ratio of the 1st and 2nd photo detector detects the wavelength of a laser beam, and the output is given to the error detector 16 here. Reference voltage is given to the input edge of another side of the error detector 16. This reference voltage is constituted so that the reference-value setting means [1] 17 VR, for example, a variable resistor, can adjust between +VCC--VDD(s). The error amplifier 16 detects the difference of this reference voltage and input voltage as an error signal, and gives an error signal to the PID-control section 18. PID control of the PID-control section 18 is carried out so that an error signal may be set to 0, and the output is constituted so that it may return to a laser diode 1 through the laser diode mechanical component 19. The laser diode mechanical component 19 controls the luminescence wavelength of a laser diode 1 to change within the limits of 2-3nm or less by controlling the current passed to a laser diode 1, or the temperature of a laser diode 1. The variable resistor VR 1 and the PID-control section 18 which give reference voltage to the error detector 16 and the error detector 16 here, and the laser diode mechanical component 19 constitute the wavelength control means 10 which controls the luminescence wavelength of a laser light source so that the power ratio by the power ratio calculation means 9 serves as a predetermined value.

[0019] The **** band pass filter 8 uses the multilayer optical interference filter which carried out the laminating of the high refractive-index film which has lambda/4 of optical thickness for film pressure to the transmitted wave length lambda, and the low refraction film by turns. And by preparing the cavity layer of lambda/2 of optical thickness in the pars intermedia, it constitutes so that it may have the optical band pass filter property of passing the light of fixed wavelength.
[0020] Next, actuation of the laser light equipment by the gestalt of this operation is explained. Incidence of the laser beam oscillated with a laser diode 1 is carried out to a cut-off filter 4 through an optical fiber 2 and a lens 3. Drawing 3 (a) is a graph which shows the property of a cut-off filter 4, and drawing 3 (b) and (c) are graphs which show the property of the permeability of the optical band pass filter 8, and a reflection factor. Beforehand, a cut-off filter 4 penetrates the light of long wave length for the main wavelength lambda 1 of this optical band pass filter 8 from this as cut-off wavelength, and chooses a property which intercepts light with short wavelength. Incidence of the light which passed the cut-off filter 4 is carried out to a beam splitter 5. Branching and the transmission ratio of a beam splitter 5 are set to 1:N here. Incidence of the laser beam which penetrated the beam splitter 5 is carried out to an optical fiber 7 through a lens 6. Incidence of the branching light reflected by the beam splitter 5 on the other hand is carried out to the optical band pass filter 8. And only the part penetrates the optical band pass filter 8, and carries out incidence to a photodiode PD 1. The optical band pass filter 8 makes the light of the predetermined wavelength lambda 1 penetrate, as shown in drawing 3 (b) and (c), and has the property of reflecting other light. Therefore, incidence of the light reflected with the optical band pass filter 8 is again carried out to a beam splitter 5, it branches by the ratio of 1:N and the transmitted light carries out incidence to a photodiode PD 2. The optical output obtained by photodiodes PD1 and PD2 to the luminescence wavelength lambda of a laser diode 1 at this time is shown in drawing 3 (d) and (e), respectively. An amplifier 12 compensates the fall of the output level accompanying optical branching of the photodiode PD 2 at this time. The output which will be obtained by I/V converter 11a and amplifier 12 if it carries out like this supports the permeability of drawing 3 (b), and the reflection factor of drawing 3 (c), respectively.
[0021] The level of the transmitted light which carries out incidence to a photodiode PD 2 is determined by branching ratio 1:N of a beam splitter 5. For example, when transparency and reflective ratio of the optical band pass filter 8 are 1:1 and the thing set up so that luminescence wavelength may be fixed, then the branching ratio of a beam splitter 5 are 1:1, as shown in drawing 4 , the light-receiving ratio of PD2 to PD1 will be fixed by 0.5. When the branching ratio of a beam splitter 5 is 1:10 similarly, as for a light-receiving ratio, 0.9 and a branching ratio are set to 0.99 by the light-receiving ratio of PD2 by 1:100. Thus, by enlarging the branching ratio N, the light-receiving level of PD1 and PD2 will approach 1, as shown in drawing 4 . Therefore, as long as a branching ratio N is large enough, 1 is sufficient as the gain of amplifier 12, and you may make it lose amplifier 12.
[0022] Therefore, if the output of I/V conversion 11a and amplifier 12 is set to A and B, these will be added and subtracted, division will be carried out with a divider 15, and (A-B)/(A+B) will be computed. By carrying out division shows the level which normalized to drawing 5 . Thus, according to the luminescence wavelength of a laser light source, a wavelength monitor signal changes continuously. the difference of the level of a wavelength monitor signal, and the reference voltage of the error detector 16 -- the wavelength of a laser diode 1 is controllable in agreement with the reference voltage set as the error detector 16 by making a value into an error signal, and controlling so that an error signal serves as zero. For example, when the output level of 0V then I/V transducer 11a, and an amplifier 12 emits [reference voltage] light in the equal wavelength lambda 2, an error signal is set to 0 and can control the luminescence wavelength of a laser diode to lambda 2. Moreover, wavelength will be locked by lambda 4 by the side of short wavelength if reference voltage is set as the level V1 of drawing 5 . Thus, luminescence wavelength can be finely tuned by changing the reference voltage of the error detector 16 within the limits of the wavelength lambda1-lambda3 shown in drawing 3 and drawing 5 .
[0023] Although the beam splitter 5 which branches a laser beam here uses what has a predetermined branching ratio, fluctuation of a branching ratio is produced in the range depending on temperature, plane of polarization, etc. If a branching ratio N changes depending on change of such temperature or plane of polarization, the level of the light received by two photodiodes PD1 and PD2 will change. However, if the branching ratio N of a beam splitter 5 is enlarged, the ratio of the amount of fluctuation received by two photodiodes PD1 and PD2 will become small as shown in drawing 6 . In drawing 6 , fluctuation of a branching ratio shows the ratio of the amount of fluctuation of PD1 and PD2 with Curves A, B, and C, respectively about three beam splitters, **0.1%, **1%, and **10%, 5. Thus, since the ratio of the amount of fluctuation will become about 0% small even if it uses a beam splitter with large fluctuation of a

branching ratio if the branching ratio N of a beam splitter 5 is enlarged, the wavelength of a laser beam is correctly fixable on predetermined wavelength.
[0024] Drawing 7 is the perspective view showing the condition of having contained branching and wavelength lock parts other than the laser light source of the laser light equipment by the gestalt of the 1st operation in the case 21 as one module. With the gestalt of this operation, a part of laser beam is carrying out incidence through the optical fiber 2, and the transmitted light of a beam splitter is outputted from an optical fiber 7. Moreover, the supply line of a power source and monitor output Rhine are established in this case. The tongue 22 for tuning luminescence wavelength finely is formed by adjusting the resistance of the variable resistor VR 1 of the reference-value adjustment means mentioned above to a case 21. Moreover, such a tongue may not be exposed outside and a case may be constituted airtightly.
[0025] Next, the gestalt of implementation of the 2nd of this invention is explained using drawing 8 and drawing 9 . With the gestalt of this operation, adjustment of the wavelength of the laser beam of the light to lock is enabled from the exterior. The same part as the gestalt of the 1st operation mentioned above attaches the same sign, and omits detailed explanation. It replaces with the optical band pass filter 8, considers as the interference light filter 30, and enables it to change the wavelength of the transmitted light continuously with the incidence location of the longitudinal direction (X-axis) of that substrate with the gestalt of this operation. And X shaft orientations are made to carry out a minute distance slide mechanically, keeping this interference light filter 30 perpendicular to a laser beam, and a sliding mechanism 31 changes an incidence location. Other configurations are the same as that of the gestalt of the 1st operation mentioned above.
[0026] Next, this interference light filter is shown in JP,7-92530,B, and uses and explains drawing 9 below. The interference light filter 30 of wavelength good transformation by the gestalt of this operation carries out the multilayer vacuum evaporationo of the matter for example, on the substrates 41, such as glass and silicon, and is constituted. The permeability of light shall constitute this substrate 41 in the range of the wavelength to be used using the high quality of the material, and a dielectric and a semi-conductor are used. Quartz glass is used with the gestalt of this operation. And in the upper part of this substrate 41, the multilayers 42, such as high vacuum evaporationo matter of the permeability of the light in the wavelength to be used, a dielectric, and a semi-conductor, are vapor-deposited. Multilayers 42 shall be formed like illustration here from the lower multilayers 43, the cavity layer 44, and the up multilayers 45. Moreover, an antireflection film 46 is formed in the inferior surface of tongue of a substrate 41 by vacuum evaporationo.
[0027] As for the matter used as a vacuum evaporationo ingredient of multilayers 42 and an antireflection film 46 here, Si O2 (refractive index n= 1.46), Ta 2O5 (n= 2.15), Si (n= 3.46) and aluminum 2O3, Si2N4, Mg F, etc. are used. Multilayers 43 and 45 carry out the laminating of the low refractive-index film and the high refractive-index film by turns, and are making them vapor-deposit with the gestalt of **** operation. It is made for Thickness d, the transmitted wave length lambda, and a refractive index n to serve as the following relation here.
lambda=4nd ... (1)
That is, each class makes the optical thickness nd lambda/4. And full width at half maximum (FWHM) of the peak of permeability is made small by accumulating the low refractive-index film and the high refractive-index film by turns. Moreover, thickness dc of the cavity layer 44 It is made to become the following relation to the transmitted wave length lambda and a refractive index n.
lambda=2ndc ... (2)
Namely, optical thickness ndc of the cavity layer 44 It may be lambda/2.
[0028] Now, since transmitted wave length and thickness have the relation of a formula (1) and (2), the interference light filter 30 by the gestalt of this operation uses a substrate 41 as a long and slender tabular substrate, sets the refractive index of multilayers 42 constant, changes thickness continuously, and he is trying to change the transmitted wave length lambda. And the transmitted wave length of this wavelength good transformation interference light filter 30 is set to lambdaa - lambdac (lambdaa <lambdac), and it is lambdab about the transmitted wave length in that central point (x=xb). It carries out. The up-and-down multilayers 43 and 45 are the 1st refractive index n1, respectively. The 2nd refractive index n2 with a refractive index lower than the 1st vacuum evaporationo matter film and this The laminating of the 2nd vacuum evaporationo matter film is carried out by turns, and it is constituted. That is, the enlarged drawing of the circular part of drawing 9 (a) is changing each thickness continuously, as shown in drawing 9 (c). In drawing 9 (c), 43L and the high refractive-index film are set to 43H for the low refractive-index film of the lower multilayers 43, and 45H and the low refractive-index film are set to 45L for the high refractive-index film of the up multilayers 45. And edge xa on the X-axis of the filter of drawing 9 (a) Transmitted wave length lambdaa It

receives, and it sets up so that the above-mentioned formula (1) and (2) may be realized by the low refractive-index film and the high refractive-index film, respectively. Moreover, xb and xc Transmitted wave length lambdab and lambdac It also receives and they are wavelength lambdab and lambdac. The thickness is set up so that a formula (1) and (2) may be realized. And change of wavelength also sets up thickness in the meantime so that it may change linearly. Therefore, each thickness of multilayers is location xa -xc on a x axis like illustration. It takes, and changes continuously and thickness becomes large toward the forward direction of the X-axis.
[0029] Thus, changing thickness continuously can be realized by leaning a substrate and arranging spacing with the source of vacuum evaporationo so that it may change continuously, in case multilayers 42 are vapor-deposited and formed on a substrate 41.
[0030] Moreover, although he is trying to change the thickness of the interference light filter 30 itself continuously, each thickness presupposes that it is fixed, and it is the refractive index n1 of multilayers 42, and n2. As it is made to change to X shaft orientations continuously, it may be made to carry out adjustable [of the optical thickness] to them continuously.
[0031] Thus, the constituted interference light filter 30 has a narrow-band property, and has the property moreover enough stabilized to the temperature change etc. Therefore, when light moves mechanically the location which carries out incidence to X shaft orientations using the slide adjustment device 31 to the interference light filter 30, the transmitted wave length itself can be changed continuously. If it carries out like this, the wavelength branching light carries out [wavelength] incidence to a photodiode PD 1 according to the slide adjustment device 31 can change, and can change the wavelength to lock.
[0032] Next, drawing 10 (a) is the perspective view showing the condition of having contained branching and wavelength lock parts other than the laser light source of the laser light equipment by the gestalt of the 2nd operation in the case 32 as one module. With the gestalt of this operation, in order to change the luminescence wavelength of a laser diode 1 a lot, the adjustment tongue 33 of the slide adjustment device 31 is rotated, and the incidence location of the incident light to the interference light filter 30 is changed. If it carries out like this, the transmitted wave length lambda 1 of the interference light filter 20 shown in drawing 3 (b) and (c) can be changed. In this case, it is necessary to use the filter with which a cut-off filter 4 also has a property according to this. If it carries out like this, the wavelength which can emit light can be changed a lot. Therefore, if the incidence location to the interference light filter 30 adjusts luminescence wavelength roughly and adjustment of delicate wavelength is adjusted by changing the reference voltage of the reference-value setting means 17, it will enable a user to set it as the wavelength of arbitration.
[0033] In addition, you may make it change wavelength only with the tongue 33 of the slide adjustment device 31, without establishing the according to variable resistor VR 1 although [it enables it to adjust the tongues 33 and 34 of the slide adjustment device 31 and a variable resistor VR 1 from the outside of a case with the gestalt of the 2nd operation], and as it is shown in drawing 10 R> 0 (b) reference-value setting means mentioned above. Moreover, it is set as wavelength required at the time of manufacture, the tongue 34 of the variable resistor VR 1 for the tongue 33 of the slide adjustment device 31 and fine tuning is not exposed to the case exterior, and it can avoid adjusting luminescence wavelength of a laser light source, as shown in drawing 10 R> 0 (c). The stabilizer which stabilized the luminescence wavelength of a laser light source with the very easy configuration can be realized without a user adjusting wavelength in detail, if it carries out like this, and a hermetic seal also becomes easy. Moreover, without exposing the tongue 33 of the slide adjustment device 31 out of a case 32, as shown in drawing 10 (d), it is good also as adjustment of only the tongue 34 of the variable resistor VR 1 for fine tuning being possible. In this case, from setting it as required wavelength according to the slide adjustment device 31 at the time of manufacture, a user can tune luminescence wavelength finely by predetermined within the limits of setting wavelength.
[0034] Next, the gestalt of operation of the 3rd of this invention is explained using drawing 1111 . Welding of not the beam splitter that vapor-deposited a metal and dielectric multilayers for the beam splitter 5 on glass but the two optical fibers is carried out, and they consist of gestalten of this operation. With the gestalt of this operation, the laser beam by which outgoing radiation was carried out is led to an optical fiber 51 through a lens 3 and a cut-off filter 4 from a laser diode 1. An optical fiber 51 is connected to a measuring device or an optical-communication device as it is. And to some optical fibers 51, it is close, other optical fibers 52 are arranged, and the part is welded. A part of laser beam which penetrates an optical fiber 51 is branched to an optical fiber 52 in the welding section 53, and as the light was mentioned above, it leads to the photodiode PD 1 which is the 1st photo detector through the optical band pass filter 8. In order to receive the light reflected with the **** band pass filter 8, the photodiode PD 2 which is the 2nd photo

detector is formed in the other end of an optical fiber 52. If it carries out like this, a part of reflected light of the optical band pass filter 8 can be received with a photodiode PD 2. Other configurations are the same as that of the gestalt of the 1st operation mentioned above. Moreover, you may constitute so that it may replace with the optical band pass filter 8 like the gestalt of the 2nd operation mentioned above and an incidence location can be shifted to X shaft orientations using the interference light filter 30. In this case, the beam splitter 5 using a glass substrate is unnecessary, and since a lens can be lessened, optical branching and a wavelength lock module can be constituted very small. Crotch article mark also decrease and low-pricing becomes possible.

[0035] In addition, although the divider which computes an adder, a subtractor, and its power ratio as a digital disposal circuit is formed with the gestalt of the 1st and the 2nd operation mentioned above, it cannot be overemphasized that you may make it compute the ratio of the output of I/V converter 11a and amplifier 12 directly. Moreover, you may enable it to set up a locking point in two locations of the slope of transparency/reflection property, as shown in drawing 3 (b) and (c), without forming a cut-off filter 4. In this case, luminescence wavelength is fixable to one point of the two locking points with the migration direction of an error signal.

[0036] Moreover, although the laser diode is used as a laser light source with the gestalt of operation mentioned above, other laser light sources may be used. Although considered as the beam splitter which welded the part using two optical fibers with the gestalt of the 3rd operation using the 1st mentioned above and the beam splitter which vapor-deposited a metal and dielectric multilayers for the beam splitter 5 on glass with the gestalt of the 2nd operation If it is made to cross or join together and constitutes as an optical branching component of 2 input 2 output using the Kohei side waveguide, it cannot be overemphasized that other various optical branching components can be used.

[0037] In addition, although the amplifier 12 which amplifies the output of I/V converter 11b in a power ratio calculation means is formed with the gestalt of operation mentioned above, the output level of a photodiode PD 2 may fix luminescence wavelength in the condition of falling with the branching ratio of a beam splitter 5. Since the output laser of photodiodes PD1 and PD2 will become almost equal if the branching ratio N of a beam splitter 5 is large enough, it becomes unnecessary moreover, to form amplifier 12.

[0038] Next, the laser light equipment by the gestalt of operation of the 4th of this invention is explained. Since the optical filter by the gestalt of the 1st and the 2nd operation mentioned above has temperature dependence, it compensates temperature with the gestalt of this operation, and enables it to output the light source of fixed wavelength irrespective of ambient temperature with it. Drawing 12 shows the configuration of the temperature-compensation means 60 for carrying out temperature compensation of the power ratio computed from the power ratio calculation means. The temperature-compensation means 60 is proofread including the temperature detection means 61 and an adder 62. The temperature detection means 61 detects the ambient temperature of the optical band pass filter 8, and the output is given to an adder 62. Since the output from the power ratio calculation means 9 has the almost linear temperature characteristic to temperature as shown in the curve A of drawing 13 , an adder 62 adds a temperature detection signal so that this may be negated. If it carries out like this, temperature compensation can be carried out very easily, and as shown in the curve B of drawing 13 , the effectiveness that the laser beam which has an almost fixed wavelength property can be outputted is acquired irrespective of ambient temperature.

[0039]

[Effect of the Invention] He is trying to control the luminescence wavelength of the light source from the ratio of the transmitted light of an optical filter, and the reflected light using a beam splitter and an optical filter according to invention of claims 1-6 of this application, as explained to the detail above. Therefore, a beam splitter can be built in, and highly precise precision of wave length can be acquired by moreover enlarging the branching ratio of an optical branching means, without being influenced by a branching ratio, a wavelength dependency, etc. of a beam splitter. Moreover, since the beam splitter is constituted from invention of claim 2 by carrying out welding of the optical fiber, optic mark can be lessened and exact wavelength control is attained with a very easy configuration. Moreover, in invention of claim 4, the effectiveness that luminescence wavelength is controllable within large limits is acquired by controlling the incidence location to an interference light filter. Moreover, in invention of claim 5, it becomes possible to tune the luminescence frequency of a laser light source finely by changing the reference value set up with a reference-value setting means. Moreover, in invention of claim 6, since a locking point can be limited to one using a cut-off filter, the effectiveness that the configuration of a wavelength control means can be made easy is acquired. Moreover, the effectiveness that the laser beam of the uninfluential fixed wavelength of ambient temperature can be outputted is acquired by detecting ambient temperature and compensating the output of a power ratio calculation means

with invention of claim 7.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Field of the Invention] This invention relates to the laser light equipment for stabilizing the wavelength of laser light sources, such as semiconductor laser used for optical communication etc., and oscillating.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] In current optical communication, the wavelength multiplex communication system to which the amount of transmissions is made to increase sharply compared with the case where the light of single wavelength is used is examined by multiplexing the light of much wavelength to an optical fiber, and communicating to it. In order to transmit the laser beam of much wavelength at intervals of 1nm or less in the band of the comparatively narrow wavelength which can amplify a lightwave signal as it is in order to realize wave-length multiple telecommunication, it is necessary to stabilize the wavelength of a laser light source enough. Moreover, in optical information processing and optical measurement, wavelength stabilization of a laser light source is an important technical problem because of informational densification or highly-precise-izing of measurement.
[0003] In order to stabilize the luminescence wavelength of a laser light source, using the component which has a wavelength property used as criteria, an error with luminescence wavelength is detected by a certain approach, and it returns to a laser light source. Therefore, the wavelength of the light or the light source which serves as criteria conventionally using equipment, the holography, the grating or the Mach-Zehnder interferometer, and Fabry-Perot interferometer which stabilize wavelength on the basis of it using absorption of an atom or a molecule is modulated by the dither, and the approach which adjusted wavelength is learned. A dither is vibrating the wavelength of light slightly by a certain approach, and luminescence wavelength is stabilized by distinguishing a difference and a direction with the wavelength which serves as criteria by this, and returning to a laser light source. Moreover, it considers as the criteria of wavelength using a multilayer interference light filter, an etalon, etc., and the approach which stabilized the luminescence wavelength of a laser light source is also used.
[0004] Moreover, in JP,60-74687,A, a dither is not applied, but the light from semiconductor laser is separated, an optoelectric transducer detects the level of the light which passes each filter using two filters with which the wavelength penetrated slightly differs, and the method of returning to semiconductor laser so that the optical intensity ratio may become fixed is proposed.

[Translation done.]

* NOTICES *

EFFECT OF THE INVENTION

[Effect of the Invention] He is trying to control the luminescence wavelength of the light source from the ratio of the transmitted light of an optical filter, and the reflected light using a beam splitter and an optical filter according to invention of claims 1-6 of this application, as explained to the detail above. Therefore, a beam splitter can be built in, and highly precise precision of wave length can be acquired by moreover enlarging the branching ratio of an optical branching means, without being influenced by a branching ratio, a wavelength dependency, etc. of a beam splitter. Moreover, since the beam splitter is constituted from invention of claim 2 by carrying out welding of the optical fiber, optic mark can be lessened and exact wavelength control is attained with a very easy configuration. Moreover, in invention of claim 4, the effectiveness that luminescence wavelength is controllable within large limits is acquired by controlling the incidence location to an interference light filter. Moreover, in invention of claim 5, it becomes possible to tune the luminescence frequency of a laser light source finely by changing the reference value set up with a reference-value setting means. Moreover, in invention of claim 6, since a locking point can be limited to one using a cut-off filter, the effectiveness that the configuration of a wavelength control means can be made easy is acquired. Moreover, the effectiveness that the laser beam of the uninfluential fixed wavelength of ambient temperature can be outputted is acquired by detecting ambient temperature and compensating the output of a power ratio calculation means with invention of claim 7.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since such a conventional approach gave a delicate change to the light source by the dither, changed luminescence wavelength, distinguished the direction electrically, detected a changed part to criteria and has fed it back to the semiconductor laser which is the light source, the light of the light source will be modulated. Therefore, it might lap with the modulating signal as information, and in order to lose the effect of a dither, there was a fault that electrical filters, such as a low pass filter, etc. were needed. Moreover, in order to use a dither, when a control system became complicated and a dither was accompanied by moving part, there was a fault that it was unreliable and a life became short. moreover -- although a beam splitter etc. is needed in the approach of JP,60-74687,A in order to branch light -- a beam splitter -- the effect of polarization of light -- winning popularity -- moreover, temperature -- a spectrum -- the ratio was changeable and there was a fault that it was difficult to make the component which branches light to stability by the predetermined ratio ideally. Moreover, there was a fault that it was difficult to manufacture two optical filters with which transmitted wave length differs slightly also about a filter.
[0006] Furthermore, in order to use a stable light, the part is added to a wavelength stabilizer using the beam splitter which branches a laser beam, and it considers as the laser beam which had others stabilized. For this reason, there was a fault that a beam splitter was needed apart from wavelength stabilization equipment.
[0007] This invention is made paying attention to such a conventional trouble, and it aims at offering the laser light equipment which can emit light in the laser beam of the wavelength which was made to unify a beam splitter and a wavelength stabilizer and was stabilized with high degree of accuracy by the very easy configuration.

[Translation done.]

MEANS

[Means for Solving the Problem] The laser light source to which invention of claim 1 of this application can change the wavelength of light continuously, The beam splitter to which incidence of the laser beam of said laser light source is carried out, and it branches the laser beam by which incidence was carried out in the transmitted light and branching light, The optical filter which incidence is carried out, and the branching light of said beam splitter makes penetrate the light of predetermined wavelength, makes reflect others, and carries out incidence to said beam splitter again, The 1st photo detector which receives the transmitted light of said optical filter, and the 2nd photo detector which receives the light which penetrates said beam splitter among the branching light reflected by said optical filter, It is characterized by providing a power ratio calculation means to compute the power ratio of said 1st and 2nd photo detector, and the wavelength control means which controls the luminescence wavelength of said light source so that the power ratio by said power ratio calculation means serves as a predetermined value.
[0009] Invention of claim 2 of this application is characterized by for said beam splitter sticking some two optical fibers, having carried out welding, and constituting in laser light equipment according to claim 1.
[0010] Invention of claim 3 of this application is characterized by said optical filter being an interference light filter constituted by carrying out the laminating of the low refractive-index film and high refractive-index film which have lambda/4 of optical thickness to the transmitted wave length lambda to multiplex by turns in laser light equipment according to claim 1.
[0011] Invention of claim 4 of this application is set to laser light equipment according to claim 3. Said interference light filter The optical thickness is continuously changed so that the transmitted wave length lambda may change continuously to the predetermined direction of a substrate. Said laser light equipment It is characterized by having further the slide adjustment device in which the incidence location to said interference light filter of the branching light which branched by said beam splitter is continuously changed to said predetermined direction.
[0012] Invention of claim 5 of this application is set to the laser light equipment of claim 1-5 given in any 1 term. Said wavelength control means An error detection means to detect a difference with a predetermined reference value for the power ratio computed by said power ratio calculation means, It is characterized by being characterized by providing a reference-value setting means to set a reference value as said error detection means, and the light source driving means which controls the luminescence wavelength of said laser light source so that the error value detected by said error detection means is set to 0.
[0013] Invention of claim 6 of this application is characterized by preparing further the cut-off filter which makes the transmitted wave length of said optical filter cut-off wavelength between said laser light sources and said beam splitters in the laser light equipment of claim 1-5 given in any 1 term.
[0014] Invention of claim 7 of this application is taken as the description which has further the temperature-compensation means which carries out temperature compensation of the power ratio computed by the account power ratio calculation means including a temperature detection means to measure the temperature around said optical filter, in the laser light equipment of claim 1-6 given in any 1 term.
[0015] According to this invention which has such a description, a laser light source is made to emit light and incidence of the laser beam is carried out to a beam splitter. A beam splitter carries out incidence of the laser beam which penetrated a part of light, branches others, and branched to an optical filter. An optical filter penetrates the light of predetermined wavelength and reflects others. The light which reflected with the light which penetrated the optical filter and penetrated the beam splitter again is received by the 1st and 2nd photo detector, respectively, and the power

ratio is computed with a power ratio calculation means. And the laser beam of predetermined wavelength can be made to emit light by controlling the luminescence wavelength of a laser light source so that a power ratio serves as a predetermined value. Invention of claim 3 realizes such an optical filter with the interference light filter by multilayers. Moreover, if the light-receiving location is changed using the interference light filter of wavelength good transformation which constituted the multilayers interference light filter so that transmitted wave length might change continuously to a predetermined direction as shown in claim 4, the luminescence wavelength of a laser light source can be changed. Moreover, in invention of claim 5, the reference value is set up with the reference-value setting means, and the difference of the power ratio and reference value which were computed by the error detection means with the power ratio calculation means is detected as an error. And by controlling a laser light source so that an error is set to 0 by the light source driving means, the luminescence wavelength of a laser light source can be tuned finely. Furthermore, by invention of claim 6, by preparing a cut-off filter between the light source and an optical filter prescribes only one slope part as a locking point among the properties of an optical filter.

[0016]

[Embodiment of the Invention] Drawing 1 is the block diagram showing the whole laser light equipment configuration by the gestalt of operation of the 1st of this invention. In this Fig., a laser light source emits light in the laser beam of one line spectrum using the laser diode (LD) 1 of a distribution feedback mold with the gestalt of this operation. The luminescence wavelength of this laser light source is controllable by the current or temperature control from the exterior in less than 2-3nm. This laser beam is led to an optical fiber 2.

[0017] The lens 3 which makes parallel light the laser beam by which incidence is carried out to the other end of an optical fiber 2 from an optical fiber 2, and the cut-off filter 4 which shades a part of light of incident light are formed, and the light which passed the cut-off filter 4 is given to a beam splitter 5. By vapor-depositing a metal membrane and the dielectric a large number film to a glass substrate, a beam splitter 5 is an optical branching means to branch light, penetrates a part of incident light, and reflects others. Incidence of the transmitted light is carried out to an optical fiber 7 through a lens 6. A measuring device, an optical-communication device, etc. which make the stable laser beam the light source are connected to the other end of an optical fiber 7. Now, the light which branched by the beam splitter 5 is given to the optical band pass filter 8. This optical band pass filter 8 is arranged at right angles to the branched laser beam, and it is constituted so that it may have fixed transmitted wave length. And the photodiode PD 1 which is the 1st photo detector is arranged in the location which penetrates the optical band pass filter 8, and the photodiode PD 2 which is the 2nd photo detector is arranged to this and a symmetric position, i.e., the location which receives the reflected light of the optical band pass filter 8 exceeding a beam splitter 5. The output of photodiodes PD1 and PD2 is given to the power ratio calculation means 9. The power ratio calculation means 9 computes the power ratio of two input signals, and outputs a monitor signal, and the output is given to the wavelength control means 10. The wavelength control means 10 controls the luminescence wavelength of a laser light source so that the power ratio by the power ratio calculation means 9 serves as a predetermined value. The luminescence wavelength of a laser light source shall be adjusted by changing the drive current of a laser diode 1, or changing ambient temperature.

[0018] Next, the power ratio calculation means 9 and the wavelength control means 10 are explained using drawing 2 . The output from the 1st and 2nd photodiode PD1 and PD2 is given to the I/V converters 11a and 11b within the power ratio calculation means 9, and is changed into a voltage signal. The output of I/V transducer 11b is given to the amplifier 12 which has the gain corresponding to the branching ratio of a beam splitter 5 later mentioned in order to compensate the output level of a photodiode PD 2. The output of I/V converter 11a and amplifier 12 is given to an adder 13 and a subtractor 14, and each output is added and subtracted and is given to a divider 15. A divider 15 normalizes the light received by photodiodes PD1 and PD2, and detects the wavelength of input light based on these power ratios. The I/V converters 11a and 1b, amplifier 12, the adder 13, the subtractor 14, and the divider 15 constitute a power ratio calculation means 9 by which the power ratio of the 1st and 2nd photo detector detects the wavelength of a laser beam, and the output is given to the error detector 16 here. Reference voltage is given to the input edge of another side of the error detector 16. This reference voltage is constituted so that the reference-value setting means [1] 17 VR, for example, a variable resistor, can adjust between +VCC--VDD(s). The error amplifier 16 detects the difference of this reference voltage and input voltage as an error signal, and gives an error signal to the PID-control section 18. PID control of the PID-control section 18 is carried out so that an error signal may be set to 0, and the output is constituted so that it may return to a laser diode 1 through the laser diode mechanical component 19. The laser diode mechanical component 19 controls the luminescence wavelength of a laser diode 1 to change within the limits of

2-3nm or less by controlling the current passed to a laser diode 1, or the temperature of a laser diode 1. The variable resistor VR 1 and the PID-control section 18 which give reference voltage to the error detector 16 and the error detector 16 here, and the laser diode mechanical component 19 constitute the wavelength control means 10 which controls the luminescence wavelength of a laser light source so that the power ratio by the power ratio calculation means 9 serves as a predetermined value.

[0019] The **** band pass filter 8 uses the multilayer optical interference filter which carried out the laminating of the high refractive-index film which has lambda/4 of optical thickness for film pressure to the transmitted wave length lambda, and the low refraction film by turns. And by preparing the cavity layer of lambda/2 of optical thickness in the pars intermedia, it constitutes so that it may have the optical band pass filter property of passing the light of fixed wavelength.

[0020] Next, actuation of the laser light equipment by the gestalt of this operation is explained. Incidence of the laser beam oscillated with a laser diode 1 is carried out to a cut-off filter 4 through an optical fiber 2 and a lens 3. Drawing 3 (a) is a graph which shows the property of a cut-off filter 4, and drawing 3 (b) and (c) are graphs which show the property of the permeability of the optical band pass filter 8, and a reflection factor. Beforehand, a cut-off filter 4 penetrates the light of long wave length for the main wavelength lambda 1 of this optical band pass filter 8 from this as cut-off wavelength, and chooses a property which intercepts light with short wavelength. Incidence of the light which passed the cut-off filter 4 is carried out to a beam splitter 5. Branching and the transmission ratio of a beam splitter 5 are set to 1:N here. Incidence of the laser beam which penetrated the beam splitter 5 is carried out to an optical fiber 7 through a lens 6. Incidence of the branching light reflected by the beam splitter 5 on the other hand is carried out to the optical band pass filter 8. And only the part penetrates the optical band pass filter 8, and carries out incidence to a photodiode PD 1. The optical band pass filter 8 makes the light of the predetermined wavelength lambda 1 penetrate, as shown in drawing 3 (b) and (c), and has the property of reflecting other light. Therefore, incidence of the light reflected with the optical band pass filter 8 is again carried out to a beam splitter 5, it branches by the ratio of 1:N and the transmitted light carries out incidence to a photodiode PD 2. The optical output obtained by photodiodes PD1 and PD2 to the luminescence wavelength lambda of a laser diode 1 at this time is shown in drawing 3 (d) and (e), respectively. An amplifier 12 compensates the fall of the output level accompanying optical branching of the photodiode PD 2 at this time. The output which will be obtained by I/V converter 11a and amplifier 12 if it carries out like this supports the permeability of drawing 3 (b), and the reflection factor of drawing 3 (c), respectively.

[0021] The level of the transmitted light which carries out incidence to a photodiode PD 2 is determined by branching ratio 1:N of a beam splitter 5. For example, when transparency and reflective ratio of the optical band pass filter 8 are 1:1 and the thing set up so that luminescence wavelength may be fixed, then the branching ratio of a beam splitter 5 are 1:1, as shown in drawing 4 , the light-receiving ratio of PD2 to PD1 will be fixed by 0.5. When the branching ratio of a beam splitter 5 is 1:10 similarly, as for a light-receiving ratio, 0.9 and a branching ratio are set to 0.99 by the light-receiving ratio of PD2 by 1:100. Thus, by enlarging the branching ratio N, the light-receiving level of PD1 and PD2 will approach 1, as shown in drawing 4 . Therefore, as long as a branching ratio N is large enough, 1 is sufficient as the gain of amplifier 12, and you may make it lose amplifier 12.

[0022] Therefore, if the output of I/V conversion 11a and amplifier 12 is set to A and B, these will be added and subtracted, division will be carried out with a divider 15, and (A-B)/(A+B) will be computed. By carrying out division shows the level which normalized to drawing 5 . Thus, according to the luminescence wavelength of a laser light source, a wavelength monitor signal changes continuously. the difference of the level of a wavelength monitor signal, and the reference voltage of the error detector 16 -- the wavelength of a laser diode 1 is controllable in agreement with the reference voltage set as the error detector 16 by making a value into an error signal, and controlling so that an error signal serves as zero. For example, when the output level of 0V then I/V transducer 11a, and an amplifier 12 emits [reference voltage] light in the equal wavelength lambda 2, an error signal is set to 0 and can control the luminescence wavelength of a laser diode to lambda 2. Moreover, wavelength will be locked by lambda 4 by the side of short wavelength if reference voltage is set as the level V1 of drawing 5 . Thus, luminescence wavelength can be finely tuned by changing the reference voltage of the error detector 16 within the limits of the wavelength lambda1-lambda3 shown in drawing 3 and drawing 5 .

[0023] Although the beam splitter 5 which branches a laser beam here uses what has a predetermined branching ratio, fluctuation of a branching ratio is produced in the range depending on temperature, plane of polarization, etc. If a branching ratio N changes depending on change of such temperature or plane of polarization, the level of the light

received by two photodiodes PD1 and PD2 will change. However, if the branching ratio N of a beam splitter 5 is enlarged, the ratio of the amount of fluctuation received by two photodiodes PD1 and PD2 will become small as shown in drawing 6 . In drawing 6 , fluctuation of a branching ratio shows the ratio of the amount of fluctuation of PD1 and PD2 with Curves A, B, and C, respectively about three beam splitters, **0.1%, **1%, and **10%, 5. Thus, since the ratio of the amount of fluctuation will become about 0% small even if it uses a beam splitter with large fluctuation of a branching ratio if the branching ratio N of a beam splitter 5 is enlarged, the wavelength of a laser beam is correctly fixable on predetermined wavelength.
[0024] Drawing 7 is the perspective view showing the condition of having contained branching and wavelength lock parts other than the laser light source of the laser light equipment by the gestalt of the 1st operation in the case 21 as one module. With the gestalt of this operation, a part of laser beam is carrying out incidence through the optical fiber 2, and the transmitted light of a beam splitter is outputted from an optical fiber 7. Moreover, the supply line of a power source and monitor output Rhine are established in this case. The tongue 22 for tuning luminescence wavelength finely is formed by adjusting the resistance of the variable resistor VR 1 of the reference-value adjustment means mentioned above to a case 21. Moreover, such a tongue may not be exposed outside and a case may be constituted airtightly.
[0025] Next, the gestalt of implementation of the 2nd of this invention is explained using drawing 8 and drawing 9 . With the gestalt of this operation, adjustment of the wavelength of the laser beam of the light to lock is enabled from the exterior. The same part as the gestalt of the 1st operation mentioned above attaches the same sign, and omits detailed explanation. It replaces with the optical band pass filter 8, considers as the interference light filter 30, and enables it to change the wavelength of the transmitted light continuously with the incidence location of the longitudinal direction (X-axis) of that substrate with the gestalt of this operation. And X shaft orientations are made to carry out a minute distance slide mechanically, keeping this interference light filter 30 perpendicular to a laser beam, and a sliding mechanism 31 changes an incidence location. Other configurations are the same as that of the gestalt of the 1st operation mentioned above.
[0026] Next, this interference light filter is shown in JP,7-92530,B, and uses and explains drawing 9 below. The interference light filter 30 of wavelength good transformation by the gestalt of this operation carries out the multilayer vacuum evaporationo of the matter for example, on the substrates 41, such as glass and silicon, and is constituted. The permeability of light shall constitute this substrate 41 in the range of the wavelength to be used using the high quality of the material, and a dielectric and a semi-conductor are used. Quartz glass is used with the gestalt of this operation. And in the upper part of this substrate 41, the multilayers 42, such as high vacuum evaporationo matter of the permeability of the light in the wavelength to be used, a dielectric, and a semi-conductor, are vapor-deposited. Multilayers 42 shall be formed like illustration here from the lower multilayers 43, the cavity layer 44, and the up multilayers 45. Moreover, an antireflection film 46 is formed in the inferior surface of tongue of a substrate 41 by vacuum evaporationo.
[0027] As for the matter used as a vacuum evaporationo ingredient of multilayers 42 and an antireflection film 46 here, Si O2 (refractive index n= 1.46), Ta 2O5 (n= 2.15), Si (n= 3.46) and aluminum 2O3, Si2N4, Mg F, etc. are used. Multilayers 43 and 45 carry out the laminating of the low refractive-index film and the high refractive-index film by turns, and are making them vapor-deposit with the gestalt of **** operation. It is made for Thickness d, the transmitted wave length lambda, and a refractive index n to serve as the following relation here.
lambda=4nd ... (1)
That is, each class makes the optical thickness nd lambda/4. And full width at half maximum (FWHM) of the peak of permeability is made small by accumulating the low refractive-index film and the high refractive-index film by turns. Moreover, thickness dc of the cavity layer 44 It is made to become the following relation to the transmitted wave length lambda and a refractive index n.
lambda=2ndc ... (2)
Namely, optical thickness ndc of the cavity layer 44 It may be lambda/2.
[0028] Now, since transmitted wave length and thickness have the relation of a formula (1) and (2), the interference light filter 30 by the gestalt of this operation uses a substrate 41 as a long and slender tabular substrate, sets the refractive index of multilayers 42 constant, changes thickness continuously, and he is trying to change the transmitted wave length lambda. And the transmitted wave length of this wavelength good transformation interference light filter 30 is set to lambdaa - lambdac (lambdaa <lambdac), and it is lambdab about the transmitted wave length in that central point (x=xb). It carries out. The up-and-down multilayers 43 and 45 are the 1st refractive index n1, respectively. The 2nd refractive index n2 with a refractive index lower than the 1st vacuum evaporationo matter film and this The

laminating of the 2nd vacuum evaporationo matter film is carried out by turns, and it is constituted. That is, the enlarged drawing of the circular part of drawing 9 (a) is changing each thickness continuously, as shown in drawing 9 (c). In drawing 9 (c), 43L and the high refractive-index film are set to 43H for the low refractive-index film of the lower multilayers 43, and 45H and the low refractive-index film are set to 45L for the high refractive-index film of the up multilayers 45. And edge xa on the X-axis of the filter of drawing 9 (a) Transmitted wave length lambdaa It receives, and it sets up so that the above-mentioned formula (1) and (2) may be realized by the low refractive-index film and the high refractive-index film, respectively. Moreover, xb and xc Transmitted wave length lambdab and lambdac It also receives and they are wavelength lambdab and lambdac. The thickness is set up so that a formula (1) and (2) may be realized. And change of wavelength also sets up thickness in the meantime so that it may change linearly. Therefore, each thickness of multilayers is location xa -xc on a x axis like illustration. It takes, and changes continuously and thickness becomes large toward the forward direction of the X-axis.
[0029] Thus, changing thickness continuously can be realized by leaning a substrate and arranging spacing with the source of vacuum evaporationo so that it may change continuously, in case multilayers 42 are vapor-deposited and formed on a substrate 41.
[0030] Moreover, although he is trying to change the thickness of the interference light filter 30 itself continuously, each thickness presupposes that it is fixed, and it is the refractive index n1 of multilayers 42, and n2. As it is made to change to X shaft orientations continuously, it may be made to carry out adjustable [of the optical thickness] to them continuously.
[0031] Thus, the constituted interference light filter 30 has a narrow-band property, and has the property moreover enough stabilized to the temperature change etc. Therefore, when light moves mechanically the location which carries out incidence to X shaft orientations using the slide adjustment device 31 to the interference light filter 30, the transmitted wave length itself can be changed continuously. If it carries out like this, the wavelength branching light carries out [wavelength] incidence to a photodiode PD 1 according to the slide adjustment device 31 can change, and can change the wavelength to lock.
[0032] Next, drawing 10 (a) is the perspective view showing the condition of having contained branching and wavelength lock parts other than the laser light source of the laser light equipment by the gestalt of the 2nd operation in the case 32 as one module. With the gestalt of this operation, in order to change the luminescence wavelength of a laser diode 1 a lot, the adjustment tongue 33 of the slide adjustment device 31 is rotated, and the incidence location of the incident light to the interference light filter 30 is changed. If it carries out like this, the transmitted wave length lambda 1 of the interference light filter 20 shown in drawing 3 (b) and (c) can be changed. In this case, it is necessary to use the filter with which a cut-off filter 4 also has a property according to this. If it carries out like this, the wavelength which can emit light can be changed a lot. Therefore, if the incidence location to the interference light filter 30 adjusts luminescence wavelength roughly and adjustment of delicate wavelength is adjusted by changing the reference voltage of the reference-value setting means 17, it will enable a user to set it as the wavelength of arbitration.
[0033] In addition, you may make it change wavelength only with the tongue 33 of the slide adjustment device 31, without establishing the according to variable resistor VR 1 although [it enables it to adjust the tongues 33 and 34 of the slide adjustment device 31 and a variable resistor VR 1 from the outside of a case with the gestalt of the 2nd operation], and as it is shown in drawing 10 R> 0 (b) reference-value setting means mentioned above. Moreover, it is set as wavelength required at the time of manufacture, the tongue 34 of the variable resistor VR 1 for the tongue 33 of the slide adjustment device 31 and fine tuning is not exposed to the case exterior, and it can avoid adjusting luminescence wavelength of a laser light source, as shown in drawing 10 R> 0 (c). The stabilizer which stabilized the luminescence wavelength of a laser light source with the very easy configuration can be realized without a user adjusting wavelength in detail, if it carries out like this, and a hermetic seal also becomes easy. Moreover, without exposing the tongue 33 of the slide adjustment device 31 out of a case 32, as shown in drawing 10 (d), it is good also as adjustment of only the tongue 34 of the variable resistor VR 1 for fine tuning being possible. In this case, from setting it as required wavelength according to the slide adjustment device 31 at the time of manufacture, a user can tune luminescence wavelength finely by predetermined within the limits of setting wavelength.
[0034] Next, the gestalt of operation of the 3rd of this invention is explained using drawing 1111 . Welding of not the beam splitter that vapor-deposited a metal and dielectric multilayers for the beam splitter 5 on glass but the two optical fibers is carried out, and they consist of gestalten of this operation. With the gestalt of this operation, the laser beam by which outgoing radiation was carried out is led to an optical fiber 51 through a lens 3 and a cut-off filter 4 from a laser

diode 1. An optical fiber 51 is connected to a measuring device or an optical-communication device as it is. And to some optical fibers 51, it is close, other optical fibers 52 are arranged, and the part is welded. A part of laser beam which penetrates an optical fiber 51 is branched to an optical fiber 52 in the welding section 53, and as the light was mentioned above, it leads to the photodiode PD 1 which is the 1st photo detector through the optical band pass filter 8. In order to receive the light reflected with the **** band pass filter 8, the photodiode PD 2 which is the 2nd photo detector is formed in the other end of an optical fiber 52. If it carries out like this, a part of reflected light of the optical band pass filter 8 can be received with a photodiode PD 2. Other configurations are the same as that of the gestalt of the 1st operation mentioned above. Moreover, you may constitute so that it may replace with the optical band pass filter 8 like the gestalt of the 2nd operation mentioned above and an incidence location can be shifted to X shaft orientations using the interference light filter 30. In this case, the beam splitter 5 using a glass substrate is unnecessary, and since a lens can be lessened, optical branching and a wavelength lock module can be constituted very small. Crotch article mark also decrease and low-pricing becomes possible.
[0035] In addition, although the divider which computes an adder, a subtractor, and its power ratio as a digital disposal circuit is formed with the gestalt of the 1st and the 2nd operation mentioned above, it cannot be overemphasized that you may make it compute the ratio of the output of I/V converter 11a and amplifier 12 directly. Moreover, you may enable it to set up a locking point in two locations of the slope of transparency/reflection property, as shown in drawing 3 (b) and (c), without forming a cut-off filter 4. In this case, luminescence wavelength is fixable to one point of the two locking points with the migration direction of an error signal.
[0036] Moreover, although the laser diode is used as a laser light source with the gestalt of operation mentioned above, other laser light sources may be used. Although considered as the beam splitter which welded the part using two optical fibers with the gestalt of the 3rd operation using the 1st mentioned above and the beam splitter which vapor-deposited a metal and dielectric multilayers for the beam splitter 5 on glass with the gestalt of the 2nd operation If it is made to cross or join together and constitutes as an optical branching component of 2 input 2 output using the Kohei side waveguide, it cannot be overemphasized that other various optical branching components can be used.
[0037] In addition, although the amplifier 12 which amplifies the output of I/V converter 11b in a power ratio calculation means is formed with the gestalt of operation mentioned above, the output level of a photodiode PD 2 may fix luminescence wavelength in the condition of falling with the branching ratio of a beam splitter 5. Since the output laser of photodiodes PD1 and PD2 will become almost equal if the branching ratio N of a beam splitter 5 is large enough, it becomes unnecessary moreover, to form amplifier 12.
[0038] Next, the laser light equipment by the gestalt of operation of the 4th of this invention is explained. Since the optical filter by the gestalt of the 1st and the 2nd operation mentioned above has temperature dependence, it compensates temperature with the gestalt of this operation, and enables it to output the light source of fixed wavelength irrespective of ambient temperature with it. Drawing 12 shows the configuration of the temperature-compensation means 60 for carrying out temperature compensation of the power ratio computed from the power ratio calculation means. The temperature-compensation means 60 is proofread including the temperature detection means 61 and an adder 62. The temperature detection means 61 detects the ambient temperature of the optical band pass filter 8, and the output is given to an adder 62. Since the output from the power ratio calculation means 9 has the almost linear temperature characteristic to temperature as shown in the curve A of drawing 13 , an adder 62 adds a temperature detection signal so that this may be negated. If it carries out like this, temperature compensation can be carried out very easily, and as shown in the curve B of drawing 13 , the effectiveness that the laser beam which has an almost fixed wavelength property can be outputted is acquired irrespective of ambient temperature.

[Translation done.]

DESCRIPTION OF DRAWINGS

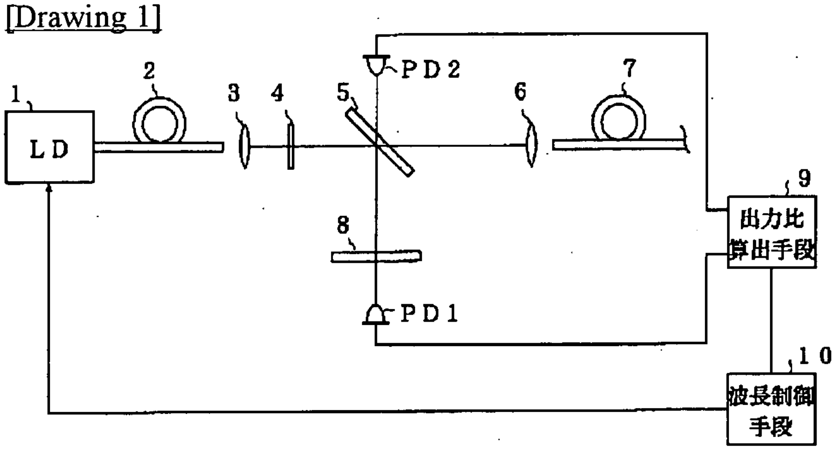
[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the whole laser light equipment configuration by the gestalt of operation of the 1st of this invention.
[Drawing 2] It is the block diagram showing the configuration of the power ratio calculation means of the laser light equipment by the gestalt of operation of the 1st of this invention, and a wavelength control means.
[Drawing 3] It is the graph which shows the property change to the luminescence wavelength of a cut-off filter, an interference light filter, and photodiodes PD1 and PD2.
[Drawing 4] It is drawing showing the power ratio of a photodiode to the branching ratio of a beam splitter.
[Drawing 5] It is the graph which shows change of the error signal over wavelength.
[Drawing 6] It is the graph which shows change of the amount of fluctuation of the output of the photodiodes PD1 and PD2 to the branching ratio of a beam splitter.
[Drawing 7] It is the perspective view showing the configuration of the optical branching and the wavelength lock module by the gestalt of the 1st operation.
[Drawing 8] It is the block diagram showing the whole laser light equipment configuration by the gestalt of operation of the 2nd of this invention.
[Drawing 9] The sectional view showing the configuration of the interference light filter of the single cavity structure according [(a)] to the gestalt of operation of the 2nd of this invention, the graph with which (b) shows change of permeability on the X-axis, and (c) are the expanded sectional views of the circular part of (a).
[Drawing 10] It is the perspective view showing the configuration of the optical branching and the wavelength lock module by the gestalt of the 2nd operation.
[Drawing 11] It is the block diagram showing the whole laser light equipment configuration by the gestalt of operation of the 3rd of this invention.
[Drawing 12] It is the block diagram showing the configuration of the power ratio calculation means of the laser light equipment by the gestalt of operation of the 4th of this invention, a temperature compensation means, and a wavelength control means.
[Drawing 13] It is the graph which shows the ambient temperature in front of temperature compensation and after temperature compensation, and the relation of wavelength.
[Description of Notations]
1 Laser Diode
2, 7, 51, 52 Optical fiber
3 Six Lens
4 Cut-off Filter
5 Beam Splitter
8 Optical Band Pass Filter
9 Power Ratio Calculation Means
10 Wavelength Control Means
11a, 11b I/V converter
12 Amplifier
13 Adder

14 Subtractor
15 Divider
16 Error Detector
17 Reference-Value Setting Means
18 PID-Control Section
19 Laser Diode Mechanical Component
21 32 Case
22, 33, 34 Tongue
30 Interference Light Filter
31 Slide Adjustment Device
53 Welding Part
PD1, PD2 Photodiode
60 Temperature-Compensation Means
61 Temperature Detection Means
62 Addition Means

[Translation done.]

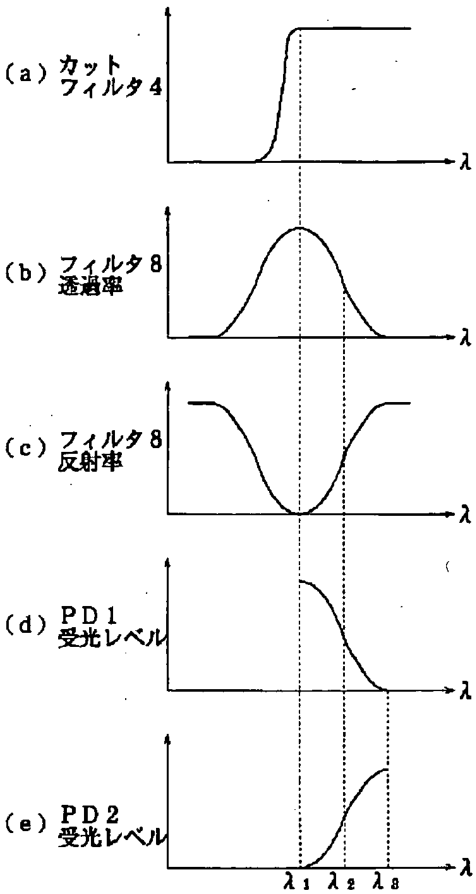
DRAWINGS

[Drawing 1]

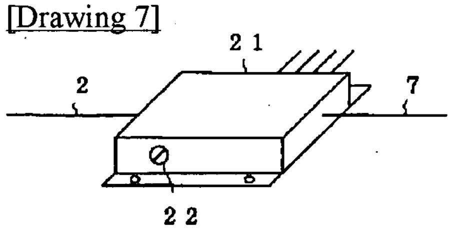


4 ------- カットフィルタ
5 ------- ビームスプリッタ
8 ------- 光バンドパスフィルタ
PD1, PD2 ------- フォトダイオード

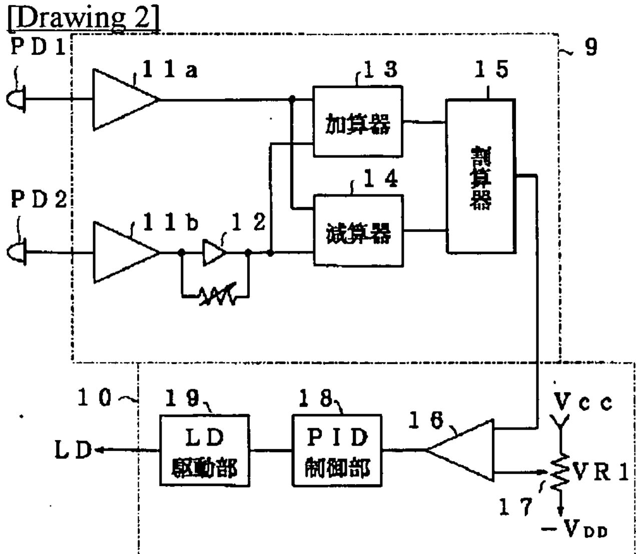
[Drawing 3]



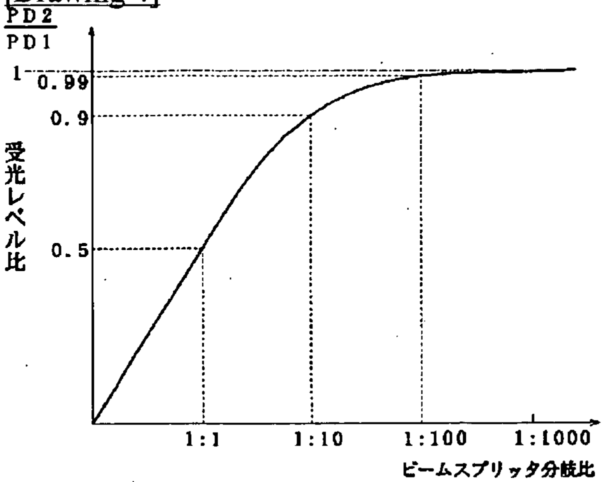
[Drawing 7]



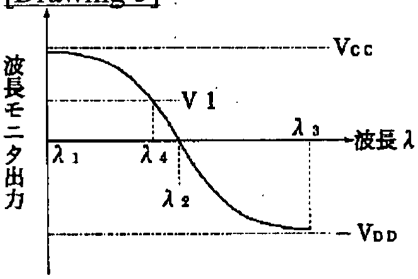
[Drawing 2]



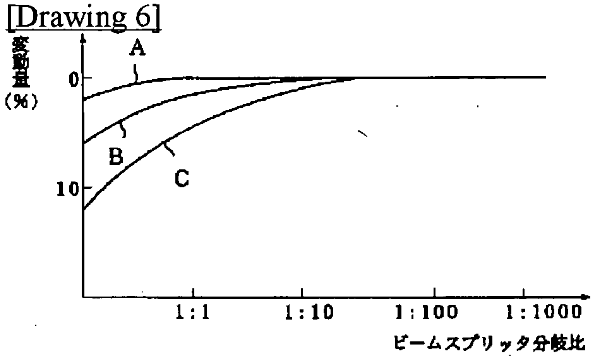
[Drawing 4]



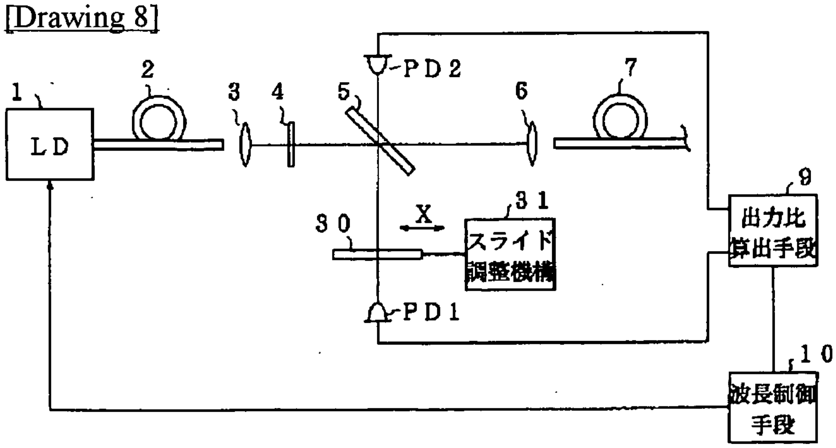
[Drawing 5]



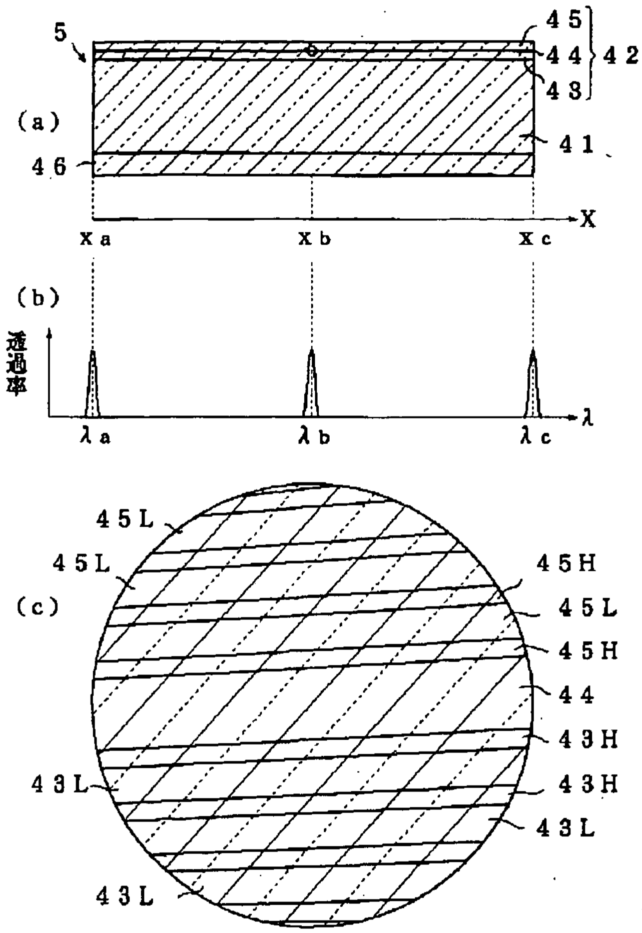
[Drawing 6]



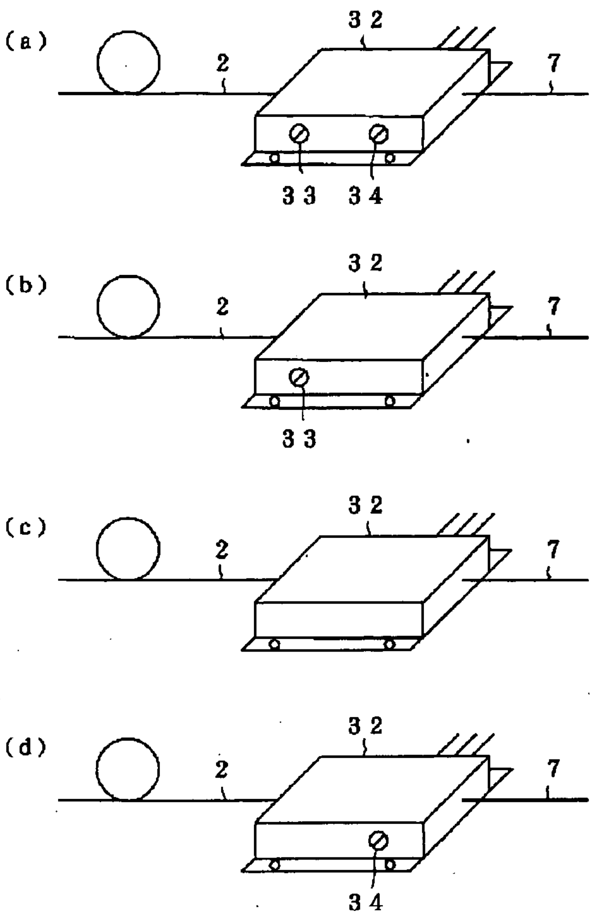
[Drawing 8]



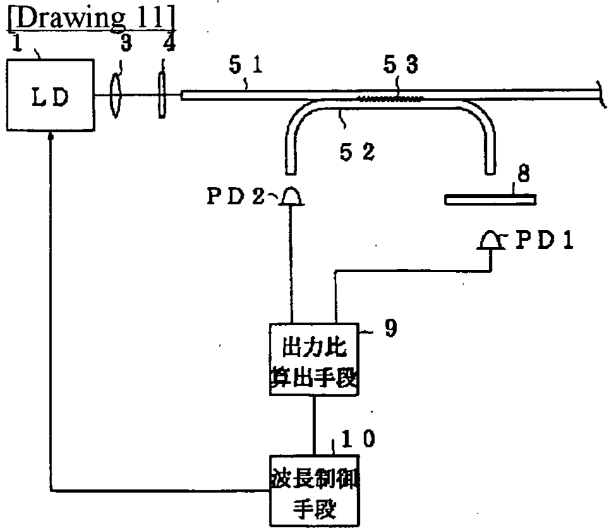
[Drawing 9]


5
45
44
43
42
(a)
41
46
X
Xa
Xb
Xc
(b)
透過率
λ
λa
λb
λc
45L
45L
45H
(c)
45L
45H
44
43H
43L
43H
43L
43L

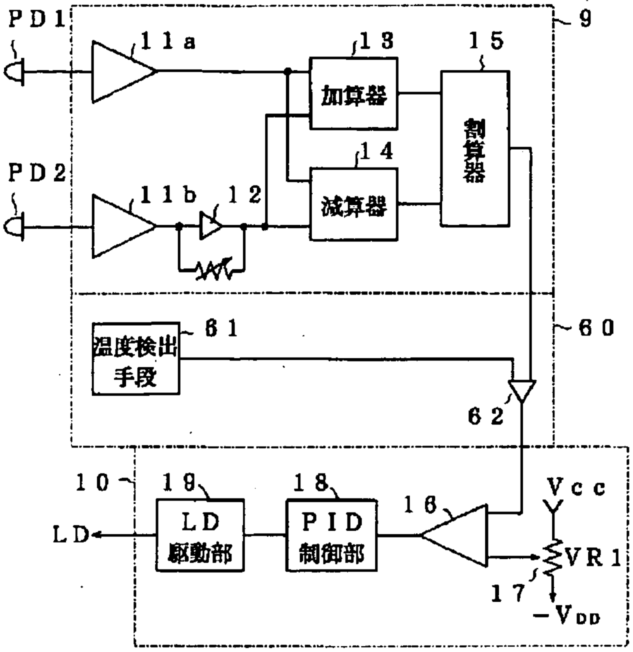
[Drawing 10]



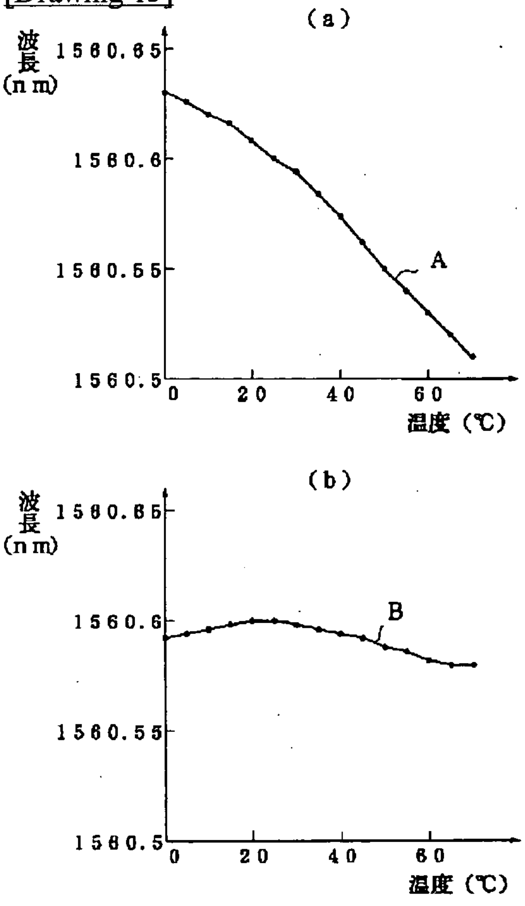
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Translation done.]